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ABSTRACT

This curriculum guide accompanies Certified: A Citizen's Step-by-Step Guide to Protecting Vernal Pools which is designed to train volunteers in the process of identifying vernal pool habitat so that as many of these pools as possible can be certified by the Massachusetts Natural Heritage and Endangered Species Program. Vernal pools are a kind of temporary pond in which salamanders and other animals breed. Forty-one activities are included and are written for amateur naturalists, biologists, botanists, and novices to the world of nature. Topics of the activities include appreciation and identification of vernal pools, compass and mapping skills, and values and political action. The appendices provide a correlation of the activities to school curricula by subject area, a glossary, a brief list of references, addresses of relevant organizations, and resources used in the activities. (DDR)

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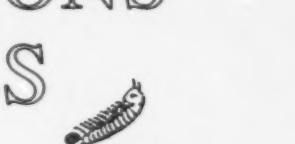
VERNAL POOL LESSONS AND ACTIVITIES



A Curriculum Companion to *CERTIFIED: A Citizen's Step-by-Step Guide to Protecting Vernal Pools*

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VERNAL POOL LESSONS AND ACTIVITIES

A Curriculum Companion to *CERTIFIED: A Citizen's Step-by-Step Guide to Protecting Vernal Pools*

Written by:

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Massachusetts Audubon Society, Lincoln, MA 01773

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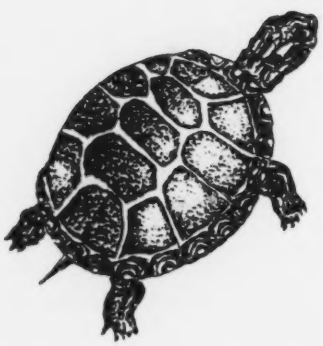

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Several activities in this book were adapted with permission from previously published sources, including: *Project WILD Aquatic Education Activity Guide*, C1987 Western Regional Environmental Education Council, *Be Expert With Map and Compass* by Bjorn Kjellstrom, Scribners, New York, 1976, pages 33 and 80-82; and "Get the Connection," Endangered Species Edition of *Ranger Rick's Nature Scope*, National Wildlife Federation, 1987, Washington, DC.

March, 1995

Preface

To the Teacher:

Vernal pools provide limitless opportunities for learning--learning about the natural world around us, about land use history, about local politics, about hands-on conservation. Present laws for protecting vernal pools give students a unique chance to become actively involved in saving a very special part of New England's wildlife in their own communities. We hope that the activities presented here will give you some ideas about involving your students in vernal pool study and protection.

This curriculum companion is intended to be used as a supplement to ***Certified: A Citizens' Step-by-Step Guide to Protecting Vernal Pools***, published by the Massachusetts Audubon Society, Lincoln, MA. It was developed at the request of and with inputs from teachers, and it includes activities that may be incorporated into school curricula in a single classroom or through an interdisciplinary approach that involves the entire school. The variety in depth of approach and complexity of the material makes it appropriate for students in grades 3 through 12.

We have divided the activities into three sections. The first section, "Appreciation, Identification, and Natural History of Vernal Pools and Their Inhabitants," deals largely (although not exclusively) with biological aspects of vernal pools. The second section, "Compass and Mapping Skills," emphasizes the skills needed for documenting the location of vernal pools in the field. The last section, "Values and Political Action," considers conservation and protection of vernal pools in the larger political context and includes the actual process of certifying a vernal pool so that it may be protected. Each section includes an introduction that summarizes the activities within it.

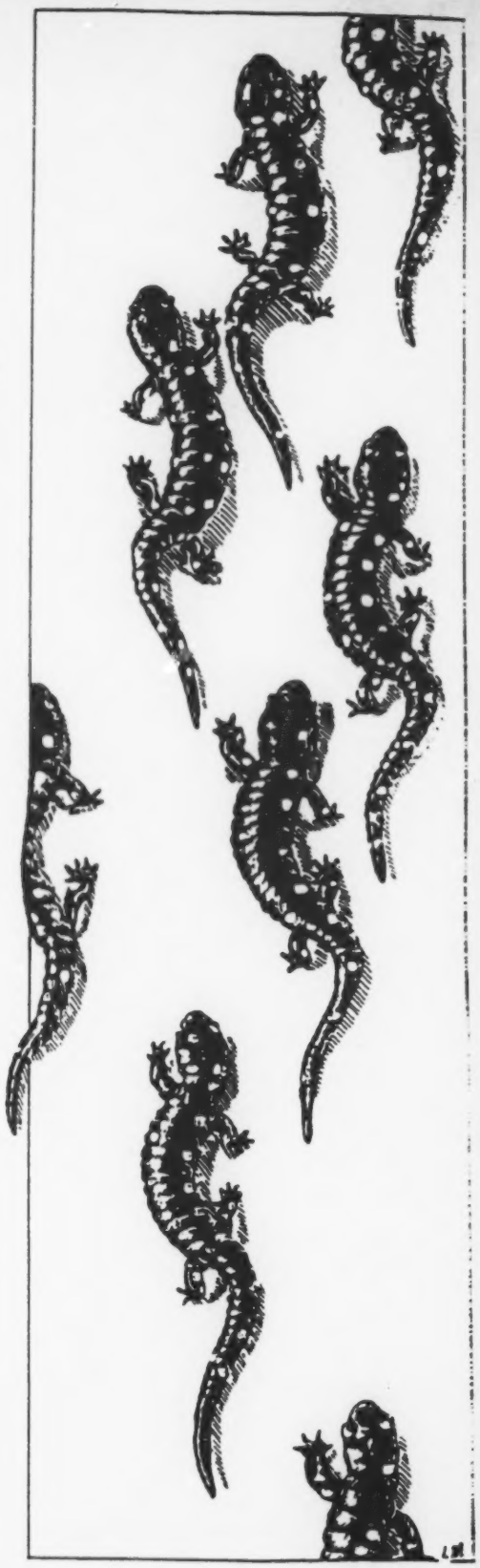
For each activity we note the discipline(s) to which the activity applies (e.g., Biology, Art, English, Math, Business, etc.), provide a list of materials, and present a brief description of the activity. For many activities, extensions and/or variations are included. Often the variations represent either extensions of the basic theme to include additional disciplines or more in-depth examinations of the subject matter, appropriate for more advanced students. Cross-references to ***Certified*** are provided, as is a list of additional resources, when appropriate.

Following the activities are five appendices. Appendix 1 lists major disciplines taught in schools and notes all of the activities that pertain to each. Appendix 2 is a glossary of terms. Appendices 3 and 4 list, respectively, sources used in perparing this curriculum companion and addresses of agencies and organizations involved in vernal pool protection and education. Appendices 5-7 consist of cards and worksheets to accompany Activities #6, 7, and 23, respectively.

We hope these activities will give you new ideas about involving your students in the study and protection of vernal pools. We hope to hear from you about your experiences. Happy ponding!

Nancy Childs and Betsy Colburn

I. Appreciation, Identification, and Natural History of Vernal Pools and Their Inhabitants



The frog does not drink up
the pond in which it lives.

Native American Proverb

Nature will bear the closest inspection.
She invites us to lay our eye level with her
smallest leaf, and take an insect view of its
plain.

Henry David Thoreau

We must look a long time before we can see.

Henry David Thoreau

Activities in Section I.

1. Getting to Know a Vernal Pool
2. Observing Vernal Pool Animals
3. Observing the Water of a Vernal Pool
4. Observing the Plant Life in and Around a Vernal Pool
5. Puddles in the School Yard
6. Vernal Pool Animal Bingo
7. Vernal Pool Animal Concentration Game
8. Vernal Pool Species Research
9. Create a Vernal Pool Animal
10. Natural History Relay Race
11. Web of Life
12. Migrating Amphibians
13. Night Hikes
14. Vernal Pool Gameboards
15. Vernal Pool Newspaper or Field Guide
16. Visual Displays of Vernal Pools
17. Raising Public Awareness--Vernal Pool Programs
18. Documenting Vernal Pool Species for Certification

Introduction

The 18 activities in this chapter provide students with a better understanding of the physical, chemical, biological, and aesthetic values of vernal pools. Many of these activities are of particular interest to biology or environmental science teachers, but other disciplines, including English, Art, Geology/Earth Science, Chemistry, Political or Social Science/Civics, and even Music have a place in this section.

Activities #1-5 involve field visits to a vernal pool or, in the absence of a convenient pool, observation of puddles in the school yard to obtain insights into some of the features of short-lived aquatic habitats. These are followed by simple games introducing vernal pool animals (Activities #6 and 7). In Activities #8-12, additional ideas for more in-depth study of vernal pool animals are presented, ranging from individual student research projects to complex games. A night hike (Activity #13) provides a different perspective on vernal pools. Students can share their understanding of vernal pools in a number or ways (Activities #14-17), from developing gameboards and visual displays, to writing articles and field guides, to presenting public programs.

* * * * *

1. Getting to Know a Vernal Pool

Disciplines: Art, Biology, English, Geology/Earth Science

Materials: Paper, pencils

Have students find a comfortable spot near a vernal pool where they can sit quietly to observe the life around them. Have them record their thoughts and observations through written or illustrated documentation. They can write poetry or essays in a journal or field notebook. Sometimes designating a specific time limit for their solo sit allows students to become more focused. (For young students a five-minute period can be a long time!) Have students memorize their exact location. Let them visit "their spot" each season or each time the class returns to the vernal pool.

* * * * *

2-5. Field Studies

Activities #2-4 involve field observations of a vernal pool, and Activity #5 uses puddles for study. A detailed analysis of a vernal pool in the field is a useful way for students to understand the uniqueness of this aquatic system. Repeating the sampling techniques and measurements over time, through seasons, or even years, allows students to become connected to a place and gives them a real understanding of a natural system and its cycles. These activities can involve Biology, Chemistry, Geology and Earth Science, English, and Art.

Students can measure many different aspects of a vernal pool. Three of them (vernal pool animals, water of vernal pools, and plant life) are described below. All of these observations can be charted for comparisons against one another and the season.

Changes throughout the season and from year to year can be monitored and discussed. For instance, comparing water temperature to rate of egg hatching or timing of invertebrate blooms may reveal some interesting correlations. Students can observe and record similarities and differences between two different vernal pools or a vernal pool and a permanent body of water. Many of the sampling techniques mentioned in the following lessons can be applied here.

If you have contacts with other schools across the state, it may be interesting to compare the seasonal changes of vernal pools in your area with theirs. The cycles of the season are fairly predictable, and experiencing this by observing a vernal pool can be a truly rewarding experience to enjoy with your students from one year to the next.

NOTE: If you are not aware of any vernal pools near the school or readily accessible for class visits, ***Certified***, Step 3, suggests ways to find vernal pools.

* * * * *

2. Observing Vernal Pool Animals

Certified: Introduction, Steps 1, 2, 3, 4, Bibliography, Appendix 1

Discipline: Biology

Materials:
- Dippers, nets, or cups for collecting free-swimming animals
- White trays
- Plastic spoons
- Hand lenses, bug boxes, field microscopes
- Field guides (see ***Certified***, Step 1 and Bibliography)
- Data sheets or notebook
- (Camera for documenting species)

Observing, identifying, and documenting vernal pool species are important components of the certification process. This activity can be combined with Activities #18, Documenting Vernal Pool Species, #24, Mapping, and #28, Certifying a Vernal Pool. It should be done in the spring after amphibian migration has occurred (see Activity #13).

Have the class observe the aquatic life from the edge of the pool first (see ***Certified*** Steps 1, 3, and 4). Look for salamander or wood frog egg masses attached to submerged branches or vegetation. Carefully collect some of the free-swimming animals and place them in white trays for close viewing. (It is unadvisable to walk into a vernal pool or collect egg masses that are attached to branches and vegetation. If egg masses become dislodged from the twigs to which they are attached, they will typically sink to the bottom of the pool where many of the developing larvae may die due to lower oxygen and light levels or predation.)

Students can use field guides to identify the different kinds of animals. They can also classify the animals as obligate or facultative vernal pool species and determine if they are indicators for certification.

Extensions/Variations

(1) Be Your Own Taxonomist

(1) Be Your Own Taxonomist. Instead of identifying animals using field guides, students can make up their own names for animals, based on characteristics that they observe. They can make up simple keys that other students can then use to identify the animals. This exercise is a great way to strengthen students' powers of observation.

(2) Animal Ecology

(2) Animal Ecology. Students should look at what they find and try to classify the organisms in terms of their environment and their interrelationships with other organisms. Possible questions include: How does the animal feed? Is it a herbivore? A carnivore? What features suggest how the animal feeds? How many trophic levels are there and what are they? How does each animal obtain oxygen? Move through the water? Reproduce?

Students can also try to predict how each kind of animal deals with seasonal drying of the vernal pool--for example, can it fly away or does it need to have an egg stage or other way of surviving once the pool dries up?

* * * * *

3. Observing the Water of a Vernal Pool

Certified: Steps 1-4

Disciplines: Geology, Earth Sciences, and Chemistry
Extensions: Mathematics, Political/Social Science and Civics

Materials: Measuring sticks and tapes, chalk
Thermometers
Water chemistry kit (Hach, LaMotte, other) for measuring dissolved oxygen
Field data sheets or notebook

Have the class observe the water of a vernal pool. Measure water temperature, water depth, pond size, and dissolved oxygen. Graph the changes in these factors over time. Ask the students to discuss what their findings tell them. How do the factors relate to one another? How do they affect the life in the vernal pool?

Extensions/Variations

(1) Predicting Annual Flooding

(1) Predicting Annual Flooding. Students can estimate the normal extent of the pool under flooded conditions by looking for moss on tree trunks, stained and saturated leaves, and the shells of snails and caddisflies in the leaf litter. The class can visit the site again in the spring to see how well their predictions are reflected in actual water levels. This is a good activity to carry out each year. A permanent marker in the field with water levels noted on it, or repeated measurements taken at the same spot each year, can provide a record from which to calculate average water levels and against which to compare a given year's flooding.

(2) Determining A Pool's Protection Status

(2) Determining a Pool's Protection Status. Isolated ponds and temporary pools are only protected under the Massachusetts Wetlands Protection Act under some circumstances (see ***Certified*** Step 2). The class can determine the surface area and volume of the pool and determine if it qualifies as a "Pond" or as "Isolated Land Subject to Flooding" (floods each year to a volume of at least 1/4 acre-foot with an average depth of at least six inches) (see ***Certified*** Appendix 3).

* * * * *

4. Observing the Plant Life in and Around a Vernal Pool

Certified: Step 2, Bibliography, Appendix 1

Disciplines: Biology
Extension: Political/Social Science and Civics

Materials: 30-foot or 100-foot tape
Field guides to plant life
Field data sheets or notebook

Although we have many vernal pool-dependent animals, in New England we have no plant species that are obligate vernal pool residents. (In Southern California, in contrast, vernal pools support a rich community of unique plants that occur nowhere else!) Plants are important to vernal pools though, as sources of leaves and other materials that decay and serve as the basis of the vernal pool food web, as substrates for egg deposition by amphibians, snails, and insects, and as contributors to habitat structure and complexity.

Students can set up 30-foot line transects from the water's edge into the surrounding areas and record the different plant species that fall along the line. Or students can record the five most common woody plants or nonwoody plants they find adjacent to the vernal pool. They can also identify plants growing in the pool and follow the succession of plants in the pool as the water recedes and new plant species appear. Each student can also choose one particular plant and observe and record its growth changes over the season.

6-7. Introducing Vernal Pool Animals

Activities #6 and 7 introduce students to vernal pool animals, their life cycles, and their interrelationships. Cards for the activities are provided in Appendices 5 and 6. Each activity is described briefly. The activities may be performed very simply with elementary school children, or with increasing complexity of information for middle and high school classes. For example, Activity #7 may be performed as a simple matching of two identical cards, or matching of two different life stages--such as egg and adult--of an animal, or having students research information about animals and present the information to the class, with the other students responsible for identifying the organism from the presented information.

* * * * *

6. Vernal Pool Animal Bingo

Certified: Step 1

Discipline: Biology

Materials: For each student (see Appendix 5):
Bingo sheet (paper divided into nine squares)
One set of nine vernal pool species cards

Describe the animals on each card, one at a time, and designate a specific square for students to place that card. Students should try to listen carefully to each description of the animals because the proper name is never given. (Example: Find the animal that has tiny suction cups on its toes and an X pattern on its back. Place that card (spring peeper) in the top right square. Find the animal that has a dark mask pattern around its eye. Place that card (wood frog) in the bottom row, middle square.) After all nine animal cards have been described and placed on the sheet, review each sheet individually.

(The cards in Appendix 6 can be used for this activity, as well.)

Extensions/Variations

(1) Partners Bingo

(1) Partners Bingo. Students work in pairs sitting back-to-back with one another with their bingo sheets and cards in front of them. Students describe the animals, one at a time to their partners, designating the proper placement of each card, being careful not to use the proper name of that animal. Each partner takes turns describing the animals and both place their set of cards on their own sheet. When all nine squares are filled, students can turn around and compare their sheets, which should be arranged identically.

(2) Categories

(2) Categories. Divide students into small groups. Give each group one set of nine vernal pool animal cards to observe. Have the students arrange animals by as many different categories as they can.

Because many pools do not dry until after the school year is over, it may be desirable to have the class visit the pool site in the fall to record plants growing in the dry or reduced basin and in the areas surrounding the pool.

Extension/Variation

(1) Is the Pool in a Wetland ?

(1) Is the Pool in a Wetland? Under state and federal laws, a "wetland" is defined in part by the presence of plant species that grow in saturated soil conditions. Students can identify plants that are classified as wetland indicator species (see ***Certified*** Step 2, p. 32, and Bibliography), research what characteristics and adaptations classify a plant as a wetland species, and determine whether at least half of the plants in or surrounding the vernal pool represent wetland indicators. (Students can ask their local conservation commission to confirm their identification of the area as a wetland or non-wetland.)

* * * * *

5. Puddles in the School Yard

Disciplines: Biology, Geology, and Earth Science

Materials: Puddles! (Or hoses, buckets, and water to make your own puddles.)
Measuring tape, rulers, thermometers
Nets, white pans, white spoons
Field guides (see ***Certified*** Bibliography)

Puddles are vernal pools in miniature form. Many puddles provide an important drinking source or breeding site for invertebrates and vertebrate species. Puddles are often more accessible for classrooms to study than vernal pools. Studying them can offer a greater understanding of their temporary nature as well as giving students some pre-field trip experience before a vernal pool visit.

Students can study all different aspects of puddles from recording measurements on their size, shape, volume, and temperature to documenting the different species of animals that live in or use them. Students can count the numbers of animals, or the numbers of kinds of animals, in puddles of different sizes. (Flour or corn starch sprinkled around the edges of a puddle and left overnight may reveal some interesting footprints of animal visitors.) Different puddles can be studied for comparisons.

Students can predict where puddles will form by the contour of the land. If the school yard is asphalt, they can mark their predictions with chalk and check their accuracy after a rain. Students can chart and graph the correlation of temperature or sunlight with the receding water level. (This activity is adapted from "Puddle Wonders," *Aquatic Project WILD*, p. 21.)

(3) Guessing. Divide students into small groups. Have each student secretly choose a vernal pool animal and write down on a piece of paper five adjectives or phrases that describe that animal. Ask students to pass their papers to other classmates to have them guess the animal they described.

(3) Guessing

(4) Who Am I? Pictures of vernal pool species are necessary for this activity. A student volunteer is asked to come to the front of the room. The volunteer is shown the picture of a vernal pool animal and quickly briefed on its habits and basic needs. (Information about the animal can be given to the student on a reference card.) The class must try to guess the name of the animal by asking yes or no questions that pertain to that animal. (Example: Are you a reptile? An amphibian? Do you live only in vernal pools? Do you migrate in the spring? Do you migrate in the fall?) The class may use up to ten questions to try to guess the name of the animal.

(4) Who Am I?

* * * * *

7. Vernal Pool Animal Concentration Game

Certified: Step 1, Bibliography, Appendix 1

Disciplines: Biology, Art
Extension: Biology, Art, English

Materials: 18 to 24 cards of duplicate sets of species that use vernal pools (e.g., two cards of wood frogs, two cards of fairy shrimp, two cards of spotted salamander, etc.) (see Appendices 5 and 6)

Shuffle the cards and place face down. Each student takes a turn by turning over two cards that are a potential match. If a match is made, a second turn is given. The game is over when all the matches have been found. (Cards can be sets of both animal and plant vernal pool species. Card pairs can also consist of a picture card and a matching written description.) NOTE: This is a good activity for older students to prepare and share with younger classes.

Extensions/Variations

(1) Life Stages. A set of vernal pool animal cards that show both the immature and mature stage of each animal is necessary for this activity (i.e., adult wood frog and a wood frog tadpole, an adult mosquito, and a mosquito larva). Students can use the set provided (Appendix 6) or draw the illustrations for the cards on their own.

(1) Life Stages

This is a good activity to follow discussions or lessons on metamorphosis and the differences among animals in their young and adult stages. Every student is handed a card of a vernal pool animal. The card will show either the mature or immature stage of an animal. They must circulate around the room to find their species match. (This activity is adapted from "Are You Me?" *Aquatic Project WILD* , p. 13.)

(2) Metamorphosis

(2) Metamorphosis. A lot of learning can revolve around the phenomenon of metamorphosis. Students can write stories and produce puppet shows and plays around this concept.

Upper-level biology students can prepare research papers on the hormonal control of metamorphosis, the physiological changes that occur in conjunction with the shift from aquatic to terrestrial life, and the understanding of development that has come from studies of amphibians.

* * * * *

8-13. In-Depth Studies

Activities #8-13 provide more in-depth explorations of the natural history of vernal pools. They include individual student research projects, night field trips to study amphibian breeding behavior, relay races that incorporate a range of natural history information to let students test how much they have learned, demonstrations of interrelationships between vernal pool species and other environmental variables, and creation of a vernal pool animal.

* * * * *

8. Vernal Pool Species Research

Certified: Step 1, Bibliography, Appendix 1

Disciplines: Biology, English

Materials: Reference books
Articles

Students can choose an obligate or facultative vernal pool species to research. Research can include such things as the life cycle, habits, range, basic needs, and life span of the animal. All the students' research information can be assembled into a field guide, presentations, or a vernal pool booklet for their class, school, or community.

* * * * *

9. Create a Vernal Pool Animal

Disciplines: Biology, Art
Extension: Biology, English

Materials: Paper, crayons, markers, paint
Clay or recycled materials for three-dimensional animals

After discussing the advantages and limitations of a vernal pool as a habitat, students can draw or build an imaginary or real animal that is adapted to live in this environment. Students should consider their animals' basic needs and adaptations in their designs.

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Extension/Variation

(1) Design a Life Cycle. Have students write the life histories of the animals they have created, including information about the animals' adaptations to the special conditions of vernal pools.

(1) Design a Life Cycle

*****

10. Natural History Relay Race

Certified: Step 1, Bibliography, Appendix 1

Disciplines: Biology, Physical Education

Materials: Vernal pool species cards, or
true or false statements about vernal pools
Bags or boxes (for depositing cards)

Reinforce natural history concepts or information with an active relay race. A simple relay game using true or false vernal pool statements could be played here. (For example, the wood frog is an obligate species [T]. Marbled salamanders migrate in the spring [F]. Mole salamanders can live more than fifteen years [T].) Students can prepare their own true and false cards. To differentiate between the teams, each team can have different colored cards with the same statements. Place True or False bags at the end of the room or a field. Divide class into teams and have each team member run up and deposit his or her card in the appropriate bag. When the game is over, check the bags and discuss the findings. For younger students, matching animal pictures to their habitat (vernal pool, permanent ponds, salt marsh, etc.) or to their scientific classification (reptiles, amphibians, mammals, etc.) could be another way of having a relay race. This is an easy activity for older students to prepare and teach to younger students.

Extension/Variation

(1) Vernal Pool Jeopardy. A teacher could use the same set of statements in the above activity to play the game of Jeopardy.

(1) Vernal Pool Jeopardy

*****

11. Web of Life

Certified: Step 1, Bibliography, Appendix 1

Disciplines: Biology, Earth Sciences

Materials: Ball of yarn or string
Vernal pool cards (cards should represent plants, animals, and elements such as rain, groundwater, or leaves fallen in the pond, that are present in a vernal pool environment)

Have the class stand or sit in a circle and give each student a card. At each step of the activity, let a student decide some way the animal or plant on his/her card is connected to and dependent on another card in the group. For instance, a salamander larva is connected to a mosquito larva as a food source. A mosquito larva is connected to rain by its dependence on water. Rain is an element necessary for an adult salamander to migrate. To illustrate a connection, have the student involved in the connection hold onto a piece of the yarn and then pass the rest of the ball of yarn to the other person involved in that connection. That student then repeats the process. When students have had a few turns at identifying and connecting their cards to others, a web pattern will start emerging in the center of the circle. One can further illustrate the interconnections by taking away one of the cards and having the student holding that card release the yarn. Often the web falls apart because everything is connected to something else in either a direct or indirect way.

*****

12. Migrating Amphibians

Certified: Introduction, Step 1, Bibliography

Disciplines: Biology, Physical Education

Materials: Large open area (school yard, gym, large classroom)
Plates or carpet squares
Chart paper

Review the cycle of amphibian migration to and from vernal pools. Discuss some of the factors that determine whether the amphibian migration and breeding cycle will be successful or unsuccessful.

Define boundaries around a large open area, preferably 70 to 100 feet in length, in which the students will be moving back and forth. (This activity could be done in a classroom, provided the classroom is large and the number of students is small.) One end of the area will represent the vernal pool habitats; the other will represent upland terrestrial habitats. On each end of the area, place a group of plates or squares (at least one square for three students) that will represent either a vernal pool or an upland terrestrial habitat.

Each of the plates representing vernal pools should have a unique color. Give one out of every ten students a white token or marker; give each of the remaining students a colored token or marker matching one of the vernal pool plates.

Explain that the students are going to represent amphibians and that they should "home" to the pools whose color matches that of their token or marker--these are the pools in which they developed as larvae. Students with white tokens can migrate to any pool the "first season," and they must then return to that pool in future migrations--they represent the portion of the population that strays to a new pool when they first start to breed.

Have the students start in their winter, upland habitat and "migrate" to their vernal pools. A maximum of three students can occupy a pool (by each having one foot on the plate) at a time. Every student should end up "in a vernal pool." After a successful migration for the first turn, have the students return to the "upland" and introduce some factors (see below) that will be illustrated by the removal or restoration of some of the plates. (For example, the construction of a road could cut off one vernal pool, or a cluster of several pools, from the upland. Some of the students will be able to migrate successfully; and others will have to try to stray into other pools or wait on the sideline. Play the game several times, introducing both favorable and unfavorable factors that could affect amphibian migrations. The plates can be removed, restored, and protected depending on the circumstance stated. Chart the differences in numbers of students migrating successfully against the different factors.

Factors Blocking Migration	Factors Favoring Migration
o new road between pool and woods	o no roads between pool and woods
o land clearing around pool	o woods extend to pool edge
o silt fencing/hay bale fence between pool and woods	o tunnels built under roads
o pesticide spraying along the way	o no pesticide spraying
o pool is gone	o pool is where it belongs

Extensions/Variations

(1) Obstacles to Migration

(1) Obstacles to Migration. Often amphibians have to cross roads and highways to reach their vernal pools. Many casualties occur at this point. To introduce this obstacle, have one student stand within a designated location of the open area. (Two ropes, parallel to each other and placed across the open area, can represent a road and the designated area.) This person represents a "car;" when any "migrating amphibians" are tagged, they must leave the game and stand on the sidelines. Amphibians must migrate across the ropes without getting tagged for a successful road crossing.

Physical obstacles such as fences, steps, and hurdles can be used to simulate silt fences, curbs, and other barriers that may interfere with amphibians' abilities to migrate to vernal pools. A time limit can be set, and only those students surmounting the obstacles within the time interval are deemed to have migrated successfully.

(2) Migrating from Ponds to the Upland Habitat

(2) Migrating from Ponds to the Upland Habitat. For a successful breeding year, both adults and their offspring must migrate safely back to their winter habitat. To demonstrate the different hurdles the larva and young may encounter, have students pair up in teams in their wintering habitat. When the teams migrate to their vernal pools, one of the students in each team will stay behind in the pool (representing the larva) while the other (the adult) will migrate back to the upland habitat. Introduce some factors that may prevent the egg and larva from successfully maturing and migrating to the upland.

Factors Blocking Maturation of Larvae (few or no new adults migrate from pool to upland)	Factors Favoring Maturation of Larvae (many new adults migrate from pool to upland)
o pool filled for development	o pool certified
o pool doesn't dry up and supports predators such as fish	o pool dries seasonally and doesn't support fish
o drought, early drying of pool	o stable springtime water level
o vernal pool predators	o sufficient rainfall
o cold temperatures kill eggs or slow develoipmental rate	o pool retains water long enough for complete growth
o insufficient food	o adequate food
o pollution of pool	o good water quality
o pesticides in pool	o no pesticides in pool

(This activity is adapted from "Migration Headache," *Aquatic Project WILD*, p. 87.)

* * * * *

13. Night Hikes

Certified: Step 1, Bibliography, Appendix 1

Disciplines: Biology
Extensions: English, Music

Much of the important activity in vernal pools occurs at night, especially in the springtime (see ***Certified***, Step 1). During the first warm, wet nights of late March or early April, salamanders, wood frogs, and spring peepers migrate to vernal pools through woods, over fields and lawns, and across roads. And, throughout the amphibian breeding season, the vocalizations of spring peepers and wood frogs, green frogs and gray tree frogs, American and Fowlers toads can be heard after dark.

Organize a nighttime visit to a vernal pool during the spring migration. Look for congressing salamanders and listen for calling wood frogs and spring peepers. (The migration occurs on the first warm, rainy night of late winter/early spring, and in eastern Massachusetts usually falls within the last two weeks of March or early April. Farther west and north the migrations may occur as late as early May, depending on the weather.)

Extensions/Variations

(1) Migration Routes

(1) Migration Routes. During the spring migration, students can look for frogs and salamanders crossing roads in their neighborhood, near the school, or in other places where they suspect there may be vernal pools nearby. When they find animals migrating, they can take pictures and record the direction in which the animals are going. Back in the classroom, students can use this information, together with maps of the area, to identify the locations of vernal pools. They can also use the information to put together a picture of the dangers and obstacles that the amphibians encounter when they are trying to reach the pools (and when they leave them and return to land.) (See Activity #12.)

(2) Amphibian Vocalizations

(2) Amphibian Vocalizations. Visit a vernal pool after dark in March, April, May, and/or early June. Listen to the calls of the frogs, peepers, or toads. Different species of frogs and toads can be identified by their calls. Students can record the calls and identify the species that make each call. If they visit the pool more than once, students can follow the succession of migrations and breeding cycles through the changes in the breeding choruses (spring peepers and wood frogs early, toads and gray tree frogs in late spring, green frogs and other frogs even later).

(3) Spring Chorus

(3) Spring Chorus. Each species of frog has a unique call that individuals use to locate one another and establish their territories. Students can create a vernal pool spring chorus using these simple sounds. Each "call" mimics the real call of that species.

Wood frog:	"Quack, quack, quack, quack"
Spring peeper:	"Peep, peep, peep, peep, peep" (up to 120 times a minute on a warm night!)
American toad:	"Brlllllllll...." (a long trill)
Green frog:	"Bink, bink, bink" (sounds like a banjo being plucked)

Divide the class into four groups and have each group represent one frog species. Create a frog chorus with all the students mimicking their frog call at once. Another version of this activity is to divide the class up into groups representing male and female frogs. The males do the calling, and the females search for the callers. This version can also be played with students blindfolded! (In nature, it is unlikely to find all these species calling from a vernal pool at one time. Toads and green frogs breed later in the season than wood frogs and spring peepers.)

(4) Creative Writing

(4) Creative Writing. A nighttime visit to a vernal pool can be a wonderfully rewarding experience that can inspire all kinds of writing. Have students write down their thoughts in essays, stories, or poetry.

14-18. Sharing Information

The following four activities provide suggestions for helping students integrate the information they have learned about vernal pools and communicating this information to other students and members of the community at large.

* * * * *

14. Vernal Pool Gameboards

Disciplines: Biology, English, Computers, Art

Materials: Art supplies, computer graphics, cardboard or other supplies for making game boards

Students can apply their knowledge about a vernal pool by making gameboards. The object of the game can vary from having the players reach a finish line after completing a successful breeding season (from a successful migration and/or metamorphosis including amphibians and invertebrates) to having players win the game by saving a pool from a development project by completing the proper certification requirements. If school resources permit, students can develop computer games.

* * * * *

15. Vernal Pool Newspaper or Field Guide

Disciplines: Biology, English, Media, Art

Materials: Paper
Art supplies
Photographic supplies

After researching and studying vernal pools, students can document their information into a field guide, book, or newspaper. Each resource could contain illustrations or photographs of its subject matter. A newspaper, modeled after a real one, could contain several sections including featured stories, editorials, comics, arts and entertainment, weather, obituaries, etc.

* * * * *

16. Visual Displays of Vernal Pools

Disciplines: Art, English, Media
Extension: Economics/Business

Materials: Art supplies
Photographic supplies

Students can create murals or T-shirts, build dioramas, and/or make felt boards and posters on vernal pools and vernal pool species. The artwork can illustrate a vernal pool in different seasons or show different stages in the lives of vernal pool organisms.

A display showing the process of vernal pool certification, with photos of students involved in studying a pool, can be an excellent way to introduce people to the vernal pool protection process.

Extension/Variation

(1) Fund-raising

(1) Fund-raising. Students can use artwork, photographs, etc., to promote and fund their certification efforts. Students at Reading Memorial High School in Reading, Massachusetts, sell amphibian T-shirts to raise money for photography equipment used for vernal pool certification documentation.

* * * * *

17. Raising Public Awareness--Vernal Pool Programs

Disciplines: All, but especially English, Media, Art

Materials: Varies with type of program (see below)

One of the best ways to protect vernal pools is to get people interested in and excited about them. Once students have become familiar with the natural history of vernal pools and have learned about salamanders, wood frogs, fairy shrimp, and other vernal pool inhabitants, they can share their knowledge with the rest of the community. Among the many options available are the following.

1. Make a video about vernal pools and certification for the local cable TV station; sponsor a showing that is open to the public in the school auditorium.

2. Prepare a public service announcement for local radio or television.

3. Take students from a lower (or higher) grade level on a field trip to see a vernal pool, and tell them about the pool and what has been done to protect it.

4. Write articles, stories or poems for the local newspaper.

5. Sponsor a vernal pool field trip/nature walk for the general public, with students serving as guides and interpreters.

6. Write a skit or prepare a slide lecture and present it to the rest of the school; invite the public to attend.

(See also, Activities #1, 4, 9, 14, 15, 16, 18)

18. Documenting Vernal Pool Species for Certification

Certified: Step 5, Bibliography, Appendix 1

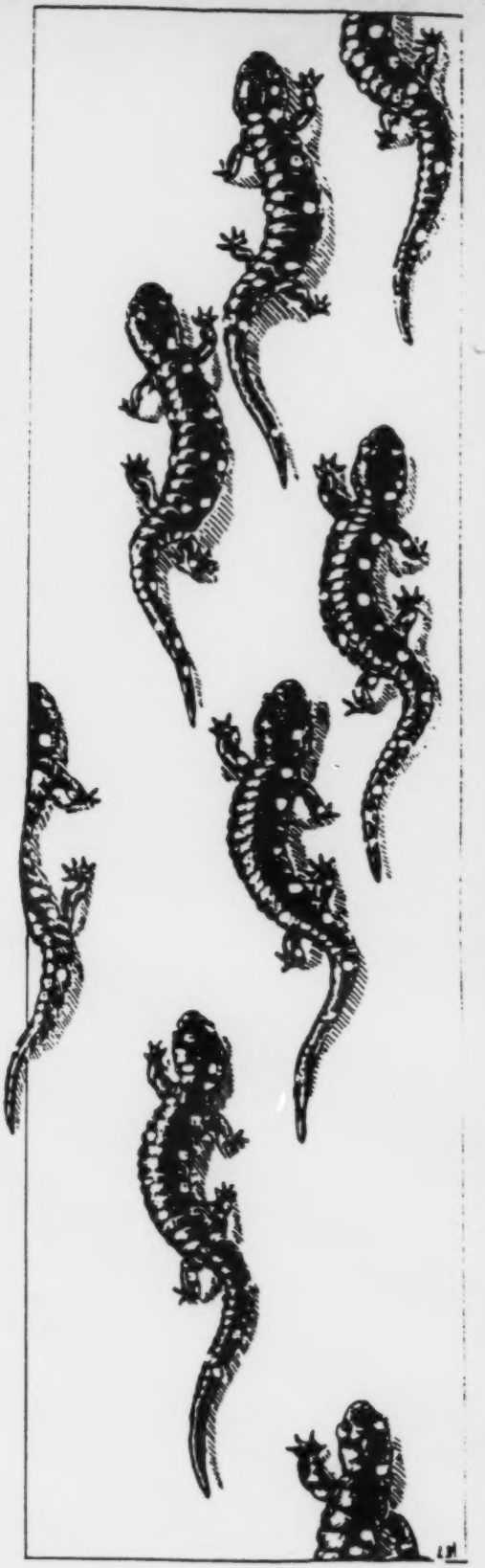
Disciplines: Biology, Art, English, Media, Political/Social Science, and Civics

Materials: Camera and film
Field data sheets or notebook
Tape recorder for documenting frog vocalizations

Documenting the presence of vernal pool species is an important part of certifying vernal pools (see ***Certified***, Step 5, and Appendix 1-- Certification Guidelines). Biology classes may wish to work with Art and/or Journalism classes to learn about the best techniques for photographing egg masses and animals in water, and for getting good photographs of small creatures. Tape recordings of frog and toad calls (see Activity #13, Night Hikes, Extension), and/or videotapes of wood frogs, salamanders, egg masses, spermatophores, or other evidence of vernal pool species can also be made. In addition to being used for certification, the documentation can be used for public programs (see Activity #17), and to supplement vernal pool newsletters, displays, or research projects (see Activities #5, 12, and 13).

Introduction

II. Compass and Mapping Skills



It is not the exotic or foreign or the occasional place that affects us most but the familiar, the small observations that most shape our points of view. People have to dig in and stay in one place long enough to learn about a spot, discover its character, and stake a future in its fate. The more we come to know our place, the more we come to know ourselves. To love at a distance is not enough.

Michael C. Shannon

Activities in Section II.

19. Pacing Geometry
20. Finding Objects by Using Compass Bearings
21. Finding Your Way
22. Reading a Map
23. Contours of the Land
24. Mapping a Vernal Pool

Introduction

When a vernal pool is certified, maps must be prepared that show the location of the pool in relation to other features of the landscape and property boundaries. This chapter presents five activities that will familiarize students with basic mapping techniques, make them more comfortable with reading maps, and improve their skills at navigating in the woods.

* * * * *

19. Pacing Geometry

Certified: Step 6

Disciplines: Physical Education, Geology and Earth Sciences, Mathematics

Materials: An open area, gym, playground or field
For each student or student pair:
Compass
Five colored 1-foot stakes, flags, or markers

This is a good activity to follow basic instruction on how to use a compass. It also allows students to practice pacing. (A pace is a double step--right, left.) Review the workings of a compass and the technique of pacing.

Have students or student pairs spread out so they are approximately 15 feet apart. Give each student or student pair a set of directions to follow. Upon completing the assignment correctly, each group will have made a geometric design with the stakes.

(Directions for a square)
DIRECTIONS:
1. Place first stake at your feet.
2. Take a bearing of 90 degrees and walk 5 paces (a pace is a double step--right, left) along that bearing and put in the second stake.
3. Walk 5 paces along a bearing of 180 degrees and place the third stake in the ground.
4. Walk 5 paces along a bearing of 270 degrees and put in the fourth stake.
5. Walk 5 paces along a bearing of 360 degrees and place the fifth stake in the ground. (If done correctly, the fifth stake should be at the first stake.)
6. Step back to look at the area you staked. What type of figure did you make? Are the sides even? Were your paces the same width for each side?

(Directions for a triangle)
DIRECTIONS:
1. Place the first stake beside your feet.
2. Take a bearing of 30 degrees and walk 5 paces (a pace is a double step--right, left) in that direction. Put the second stake in the ground.

3. Walk 5 paces along a bearing of 150 degrees and place the third stake in the ground.

4. Walk 5 paces along a bearing of 270 degrees and place the fourth stake in the ground. (If done correctly the fourth stake should be at the first stake.)

5. Step back from the area you staked out. What type of figure did you make? Are the sides equal in length? Were your paces the same width for each side?

(Activity adapted from *Be Expert with Map and Compass* by Bjorn Kjellstrom, 1976, Scribners, NY, pages 80-82.)

* * * * *

20. Finding Objects by Using Compass Bearings

Certified: Step 6

Disciplines: Physical Education, Geology and Earth Sciences

Materials: For each student:
Compass
Bearing card (a card with a compass bearing number on it)
Paper, pencil

This exercise can be carried out in the school yard, in the woods or a park, in the classroom, or in a school gym. Prepare cards by writing a bearing number on each one. Place bearing cards in a big circle. (Make sure there is a card for each student.) Hand out a sheet of paper that has a list of all the bearing numbers. Each student is asked to stand by one of the bearing cards and take that bearing with his or her compass. On each line of sight, students should identify a prominent object (for example, boulder, flagpole, oak tree, dumpster) and record that object onto their bearing sheet next to the appropriate bearing number. Upon a signal from the teacher, students should rotate to the next bearing card and repeat the exercise. When students have completed their worksheets, compare the objects recorded with the bearings to see if they match.

* * * * *

21. Finding Your Way

Certified: Step 6, Bibliography

Disciplines: Physical Education, Geology and Earth Sciences, Mathematics

Materials: Compass for each student or student pair
Course directions or control cards
School yard, park, or wooded area

Set up a course prior to the lesson. Either give the course directions to the students orally, or give each group written directions. Another method is to put directions on control cards at different stations set up along the course. If you use control cards, have the students check off their names at each station to verify they have reached that location. For example, some directions might read: [CARD 1]: Go approximately 15 paces at 270 degrees to a moss-covered boulder. (At the boulder there could be a control card where students check off their names and read the next direction.) [CARD 2]: Take approximately 26 paces at 140 degrees to find the next control card. [CARD 3]: Walk approximately 17 paces at 160 degrees until you reach a big old white oak tree. Surprises at the end of a course, such as a vernal pool, are always a treat!

Extensions/Variations

(1) Estimating Pace Length

(1) Estimating Pace Length. An average adult's pace is five feet. Students can determine their own pace by measuring out 100 or 400 feet and walking that distance counting their paces. The total number of paces divided by 100 or 400 will give them their individual pace. The directions on the course can then be given in compass bearings and distances in feet; students must calculate the appropriate number of paces to the next control point.

(2) Other Courses

(2) Other Courses.There are many ways to set up and follow a course. Students can use maps in place of cards to indicate directions, or, instead of following a series of course directions, students can use their compasses and knowledge of their pace length to prepare a course from a starting point to a goal. Have students work in pairs or teams to determine a series of bearings and distances to successive features in the school yard, park, or wooded area and write them down. The teams then exchange their results with other students who must then follow the directions to the end point.

*****

22. Reading a Map

Certified: Step 6, Addresses, Bibliography

Disciplines: Physical Education, Geology and Earth Sciences, Mathematics

Materials: Topographical maps
Symbol cards (optional cards with map symbols such as--a road, building, tower, cemetery, etc.).

Give each student a topographical map to study. Discuss what the different symbols mean. Let students use the scales to measure distances between different places. Have students answer questions about their maps.

Some example questions might include the following. Find the symbol that indicates a radio tower. Look for it on your map. What kind of terrain is the tower on? Steep slope? Level? Wet? Dry? Look for a cemetery on your map. What is the name of the river north of this cemetery? What direction does it flow? From the first intersection north of the cemetery measure a distance of 1/2 mile east and describe the terrain between these two points.

Extension/Variation

(1) Map Relay

(1) Map Relay. A simple relay can be played with map symbol cards. Divide the class into two teams, and for each team have a set of map symbol cards that correspond to the symbols on a topographical map. Students from each team pick up a symbol card and run to the map in front of the group to try to correctly place the symbol where it belongs.

* * * * *

23. Contours of the Land

Certified: Bibliography, Appendix 3

Disciplines: Physical Education, Geology and Earth Science, Mathematics

Materials: Topographical maps
Rock, pan, chalk, water
Contour/outline sheets (see Appendix 7)

Rock Demonstration (Introduction):

Either do this demonstration in front of the class or have students do it in small groups. Place a rock in a pan of shallow water. Mark the water line around the rock with a piece of chalk. Add water and mark the line again. Continue adding water and marking the water level until the top of the rock has been reached. Take the rock out of the water and look at it from above. Draw the comparisons between the water level lines and contour lines on a topographical map.

Contour Matching:

After the rock demonstration, have students either draw a set of contour lines corresponding to the outlines provided in Appendix 7, or match the appropriate contours and outlines. You may wish to reverse the orientation of the cards so that they represent pool basin contours, rather than hills. (This activity is adapted from *Be Expert with Map and Compass* by Bjorn Kjellstrom, 1976, Scribners, NY, p. 33.)

Extensions/Variations

(1) Three-Dimensional Maps

(1) Three-Dimensional Maps. Have students make a three-dimensional model of a topographical map, using cardboard or plywood, clay, rocks, sand, soil, branches, recycled materials, etc. A large map can be divided into smaller sections with individual students or small student groups working on one part of the whole map. Maps of the school yard or a familiar place (including a vernal pool!) would be ideal to use. The model can be done to scale with attention to detail appropriate to the ages and interests of the students. It can be made to be very realistic. Meadows can be planted with rye seed. Forests can be created with twigs for trunks and lichen or colored cotton balls for leaves. Moss can cover the forest floor. Buildings, roads, trails, fences, wildlife, and vernal pools can all be a part of the landscape. These models can serve as a wonderful visual aid when discussing amphibian migration routes, land use issues, and other scenarios.

(2) Mapping the Contours of a Vernal Pool

(2) Mapping the Contours of a Vernal Pool Basin. The size and shape of a vernal pool basin can be important for several reasons. First, to be certified, the pool must be an isolated basin that, for at least part of the year, does not have a stream flowing into or out of it. Second, to be protected under the Wetlands Protection Act, the pool must fill to a certain minimum volume and depth each year. The class can map the contours of the vernal pool basin to document whether there is an inlet or outlet, and to determine whether the pool meets the minimum volume requirements under the state wetlands law. (See Activity #3, Extension.)

* * * * *

24. Mapping a Vernal Pool

Certified: Step 6, Appendix 1

Disciplines: Physical Education, Geology and Earth Sciences, Political/Social Science and Civics

Materials: For each student or student group
- Topographical map
- Compass
- Rope or twine
- Tape measure or yard stick

School yard, park, or wooded area with a vernal pool

Accurate mapping of a vernal pool is a necessary part of certification documentation. A vernal pool's location must be indicated on a USGS topographical map as well as on a tax assessor's map or a similar one that shows ownership and property lines. In addition, in order that staff from the Natural Heritage and Endangered Species Program or the local conservation commission can find the vernal pool in the field, if necessary, the pool must also be located precisely.

This can be done in one of three ways:

1. by showing the pool on an aerial photograph, if one is available;
2. by a professional survey; or
3. by providing distances and compass bearings from at least two permanent landmarks; this is the most common method. These distances and compass bearings ("metes and bounds") can be provided in the written directions to the pool, but it is also a good idea to show them on a field or sketch map of the pool.

Divide the students into pairs or groups. Give each group the following tasks.

1. Write clear and concise directions to your pool using compasses and two permanent landmarks as reference points.
2. Draw a field map of your pool, noting its location relative to these permanent landmarks. Sketch in the surroundings. Include specific features (e.g., old trees, big boulders, stone walls, etc.).
3. Measure the pool and record its dimensions on the field map.

Extensions/Variations

(1) Locating the Pool on Topographic and Assessors Maps

(1) Locating the Pool on Topographic and Assessors Maps. To be complete, the certification application must show the location of the vernal pool on the appropriate USGS topographic map and the municipal tax assessors map. Give each student a photocopy of the local USGS quadrangle map and assessors map and have them mark the location of the pool on the maps. (Having students take a trip to the assessors office to learn about the local tax mapping procedures and to get a copy of the appropriate map can also be a valuable learning experience.)

(2) Relocating a Pool

(2) Relocating a Pool. If the class maps more than one pool, or if other classes (for example, in previous years) have determined directions to vernal pools, students can try to locate pools in the field by following these directions. If the class is determining directions and bearings to a single pool, it is still useful to have students exchange their results with one another. Each group becomes responsible for finding the pool using another group's directions, and for critiquing that group's work.

(3) Practicing Vernal Pool Mapping Skills

(3) Practicing Vernal Pool Mapping Skills. If a vernal pool is not easily accessible to practice these skills on, teachers can use the school yard, a local park, or a wooded area for this purpose. Prior to the lesson, mark off with rope two to six imaginary vernal pools in the school yard, park, or wooded area. The pools can be of varying sizes and shapes, but their edges should clearly be outlined with the rope. Have students work in pairs or small groups. Assign each group a vernal pool and give them the same tasks as written above. If you are able to obtain a topographical map for the area of this exercise, have students sketch in the exact location of their pool on their maps.

III. Values and Political Action

It would be worth the while if in each town there were a committee appointed to see that the beauty of the town received no detriment.... As in many countries precious metals belong to the crown, so here more precious natural objects of rare beauty should belong to the public.... I think that each town should have a park, or rather a primitive forest, where a stick should never be cut for fuel, nor for the navy, nor to make wagons, but stand and decay for higher uses - a common possession forever, for instruction and recreation.

What are the natural features which make a township handsome? A river, with its waterfalls and meadows, a lake, a hill, a cliff or individual rocks, a forest, and ancient trees standing singly. Such things are beautiful; they have a high use which dollars and cents never represent. If the inhabitants of a town were wise, they would seek to preserve these things, though at a considerable expense.

Henry David Thoreau

Activities in Section III.

25. Heroes in Conservation
26. Opinion Polls
27. Mock Public Hearings
28. Certifying a Vernal Pool

Introduction

Vernal pool protection involves more than documenting biology and making maps; it also involves an understanding of broad conservation issues such as property rights, attitudes of people to wildlife, legal procedures, and the role of citizens in local government and decision making. The activities in this chapter provide a variety of perspectives on conservation, including biographical studies of conservationists, public opinion polls, public hearings, and, finally, actively getting a vernal pool certified.

* * * * *

25. Heroes in Conservation

Disciplines: History, English, (Political/Social Sciences and Civics)

Materials: Reference books, articles, films (a visit to the library)

Have students pick and research the life and works of individuals who have made great contributions to the environmental movement. (i.e., Henry David Thoreau, Rachel Carson, Aldo Leopold, John Muir, David Brower, John Burroughs, Edward Abbey, Ann Zwinger, Wendell Berry, Marion Stoddard, Gary Snyder, Theodore Roosevelt, Mary Austin, etc.). Students can research a person and write papers focusing on the accomplishments, struggles, and philosophies of these people as well as comparing how these peoples' situations relate to the students' lives and how relevant their thoughts are to our time.

Extensions/Variations

(1) Role Playing

(1) Role Playing. Have students know enough about their conservation leader to role play that individual in an interview session. Stage a press interview in which some students act as interviewers and others pose as their chosen conservation leader.

(2) Local Heroes

(2) Local Heroes. Have students find out about people in the local community who are active in land conservation and vernal pool protection. Students can meet and interview them, recording oral histories or writing reports.

* * * * *

26. Opinion Polls

Disciplines: Political/Social Sciences and Civics, English, Biology

Materials: Reference books, articles, films

Discussions about our attitudes as a society toward wildlife can be a valuable addition to any classroom. Which do we value more,

a giant panda or a spadefoot toad? An elephant or a marbled salamander? An eagle or a fairy shrimp? These considerations can be brought out from a simple opinion poll or debate.

Some questions the class might consider include the following.

1. Which is more important to save: an endangered plant or animal?
2. Suppose that your school would like to build a new science center but the location for the building is located on a vernal pool that is a major breeding site for the marbled salamander. Should the school go ahead and build the science center? Explain your answer.
3. Would you give the same answer if you knew a bald eagle were nesting on the site? Please explain your answer.
4. For each choice below, list which group of organisms you think is more important to save and why?
   a. Large animals or small animals.
   b. Animals that are useful to people (i.e. for food and clothing) or those that have no value as a resource.
   c. Animals or plants.
   d. Animals that are beautiful or those that are not appealing.
   e. Mammals or invertebrates.
5. You are part of a team that is in charge of saving ten animals from the list below. You have only enough time and money to save five of these species. Starting with #1 as the most important, rate them in the order you would try save them. What information would you find helpful to make your decisions?
   a. Northern right whale
   b. Marbled salamander
   c. Pale green orchid
   d. Intricate fairy shrimp
   e. Spadefoot toad
   f. Bald eagle
   g. Timber rattlesnake
   h. Spring blue darner dragonfly
   i. Short-eared owl
   j. Indiana myotis (bat)
6. Which is more important: the right of the public to enjoy wildlife and open spaces, or the right of property owners to do what they want with their land? Should your neighbors be able to control the kinds of plants you grow in your yard?

(Adapted from "Get the Connection," Endangered Species edition of *Ranger Rick's Nature Scope*.)

Extensions/Variations

(1) Noah's Ark

(1) Noah's Ark. A vernal pool in your community will be obliterated by a bulldozer. You can save only five of the vernal pool species listed below. Which ones will you pick and why?

Four-toed salamander
Fairy shrimp
Marbled salamander
Wood frog
Mayfly
American toad
Gray tree frog
Damselfly
Blue-spotted salamander
Spotted turtle

(2) Choices

(2) Choices. Hold up pictures of various animals and ask students questions about them. Which would they like to save? Why? What makes one animal more appealing or valuable than another? Explain.

(3) Perceptions of Wildlife in the School or Community

(3) Perceptions of Wildlife in the School or Community. Have the class conduct an opinion poll of the student body of the school. This could be done through articles in a school newspaper or through polls distributed in homerooms or in social studies classes. Students could poll the opinions of citizens of the community through an article in the local newspaper or through public service announcements on local-access cable TV and radio stations. Depending on the size of your community, it may be interesting to compare the opinions of students in different elementary, middle, or high schools, or to compare elementary and high school students' opinions. If your school has contacts with other schools in the region or elsewhere in the United States, or even in other countries, students in the other school could conduct a similar poll, and the classes could then compare the differences between schools, regions, or countries.

(4) Changes in Public Opinions of Wildlife Over Time

(4) Changes in Public Opinions of Wildlife Over Time. Students can conduct research into public opinions about wildlife and conservation over time. Good sources are journals of early settlers and explorers, as well as nature writings from different time periods. Students can report on their findings and discuss changes in public attitudes to wildlife in the United States in colonial times, during westward expansion, early in the 1900's, and in the latter part of this century. Major events such as the passage of the Endangered Species Act and court cases addressing protection of wildlife can also be discussed in the context of changes in (and forces leading to changes in) public opinions.

* * * * *

27. Mock Public Hearings

Certified: Step 2, Bibliography, Appendices 1, 4, and 5

Disciplines: Political/Social Sciences and Civics

Present a scenario where a vernal pool in your community is being threatened by development.

For example: A 100-acre parcel of land is being put on the real estate market in your town. Eighty acres of the site consist of a mature oak hickory woodland where several of the trees are over 150 years old. In the center of the woods is a large vernal pool that is over half an acre in size. Twenty acres of the parcel are red maple swamp that border the eastern side of the oak hickory forest. A 35-acre cattail marsh owned by the town and maintained by the conservation commission abuts the red maple swamp.

Divide the class into several groups with each group representing a different interest in the parcel of land. Individual groups could include the following.

Conservation Commission: Upholds the Wetlands Protection Act and protects local open space.
Developer: Wants to build a shopping mall, which would provide services and jobs to the community.
Private Landowner: Wants to sell land at maximum profit.
High School Teacher and Ecology Class: Have visited the site and the vernal pool; have found obligate species breeding in the pool.
Small Citizens Group (comprised mostly of neighbors who have lived next to the land for decades): Wants to preserve the site in its natural state.
Board of Selectman or Mayor: Wants to increase the local tax base.
Local Contractors: Want jobs building the mall.
Local Business Owners: Fear competition from the mall.

Have students work in their groups gathering information and preparing a stand on their interest in the land. Student groups can then debate their issues in a "public meeting" with all the parties involved. Encourage the students to find legal and realistic reasons supporting their statements. Discuss the pros and cons of our present legal systems, Wetlands Protection Act, and lifestyles.

Extensions/Variations

(1) Public Hearings

(1) Public Hearings. Attend a real public hearing or a local conservation commission meeting. Interview town officials or politicians involved in land use decisions (e.g., town engineer, town manager, selectman, conservation commissioners, etc.).

(2) Local Land Use Laws

(2) Local Land Use Laws. Research open space plans, zoning laws, local bylaws, or other land use regulations that pertain to your community. See what concerns and regulations are addressed in these documents.

(3) Open Space Protection

(3) Open Space Protection. Find out about organizations that work toward protecting open space. What work do they do and how do they achieve their goals?

4. Wetlands Protection Laws. Have students research wetlands protection at the state and federal level. What are the laws and how are they practiced?

(4) Wetlands Protection Laws

5. Property Rights. Discuss and research private property rights vs. public rights. What motivates groups such as the "Wise Use" Property Rights Movement or the Earth First organization?

(5) Property Rights

6 History of Conservation. Have students research the history of conservation, wildlife protection, and endangered species legislation in the United States.

(6) History of Conservation

7. Economics, Lifestyles, and Conservation. Discuss the relationship between economic growth, lifestyles (wants versus needs), and a healthy and balanced ecosystem.

(7) Economics, Lifestyles, and Conservation

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28. Certifying a Vernal Pool

Certified: All, but especially Appendix 1 (Vernal Pool Certification Guidelines and Field Observation Form)

Disciplines: Biology, Geology and Earth Sciences, Art, Physical Education, English, Political/Social Sciences and Civics, Economics and Business

Certifying a vernal pool ensures that, as long as the proper legal procedures are followed in the future, the pool will be permanently protected as wildlife habitat. Certification can be accomplished by students in biology classes, the school's ecology club, or in interdisciplinary teams that may involve all of the students of a given year (e.g., the class of 1998), or all of the students in the school, with each grade carrying out part of the process. In fact, the entire school system can be involved in vernal pool protection, with elementary students learning about general natural history and teaching their parents to appreciate vernal pools, junior high or middle school students finding and mapping pools, and high school students documenting vernal pool indicator species and assembling the certification documentation for submission to the Natural Heritage and Endangered Species Program. Older students can teach students in the lower grades, and students of all ages can help educate the public about vernal pools.

All of the different disciplines can be involved. For example, students in economics or business classes can be responsible for developing a budget and keeping account of expenses for certification--travel, photographic materials and supplies, photocopying, postage; for keeping records for townwide certification efforts; and for developing a fund-raising strategy for the science club or other group actively involved in vernal pool certification.

English classes can sponsor poetry contests or write stories and news articles for school and community newspapers.

Math students and computer whizzes can develop computer games based on vernal pool life cycles, or they can put together data bases for storing records of vernal pools that have been certified or information on a given pool's water levels, chemistry, temperatures, and aquatic life from year to year.

Math and physical education classes can work together to determine bearings and distances to vernal pools so that the field directions and maps will be accurate.

Art students can publicize the school's certification efforts through posters, paintings, photography contests, and other media, and they can participate in the documentation process by photographing or illustrating vernal pool animals.

History and political or social science students can work with municipal officials such as conservation commissioners.

Chemistry and earth science classes can collect information on year-to-year and season-to-season variations in vernal pools and relate them to climate, land use, and other factors.

And biology students can identify the obligate or facultative vernal pool species that must be shown to be present if a pool is to be certified.

(See also Activities #18 and 24.)

Appendix 1. List of Activities Related to Vernal Pool Protection for Incorporation into School Curricula, by Academic Discipline

Art

1. Creative art projects -- painting, drawing, sculpture, diorama, collage, puppetry, sewing, other (Activities #1, 7, 9, 14, 15, 16, 17
2. Poster/postcard/T-shirt design contest to increase public awareness (Activity #16)
3. Photographic documentation of species and isolated pool depression for certification purposes (Activities #3 [Extension], 18, 24, 28)
4. Biological illustration for education about or documentation of species in vernal pools (Activities #6, 7, 18, 28)

Biology and Chemistry

1. Identifying and documenting obligate and facultative vernal pool species in pools for certification; learning about the different species' biology (Activities #1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 28)
2. Evaluating populations--counting egg masses from year to year, assessing hatching success, keeping records of invertebrates found in pools from one year to the next--and learning about interrelationships between different species in pools (Activities #2, 8, 11, 13)
3. Monitoring water quality in vernal pools and permanent ponds--temperature and dissolved oxygen at the surface and bottom are good things to monitor and relate to the organisms in the pool (Activities #3, 5)
4. Relating water chemistry, temperatures, and depths to biological communities in vernal pools (see Earth Science #4, as well) (Activities #2, 3, 4, 5, 8, 9, 11)

Economics/Business

1. Developing a budget and keeping account of expenditures for certification -- travel, photographic materials and supplies, etc. (Activities #18, 24, 28)
2. Developing a fund-raising strategy for the science club or other group actively involved in vernal pool certification--could include designing sales items such as T-shirts, posters, bumper stickers (see Art listing), production, marketing, and accounting (Activity #16)
3. Record-keeping for townwide certification efforts (Activity #28)

English/Media

1. Keeping a field journal documenting findings about vernal pools (Activities #1, 2, 3, 4, 5, 13, 18, 24, 28)
2. Writing an article for the school newspaper or the local newspaper, preparing a public service announcement for a local radio station, or making a video for local cable, about the school's vernal pool certification efforts or the natural history of vernal pools (Activities #15, 16, 17, 28)
3. Writing a poem, story, play, or game on a vernal pool-related topic (Activities #1, 7, 9, 13, 14)
4. Writing a paper on an aspect of vernal pool protection or natural history (Activities #8, 25, 27)

Geology and Earth Science

1. Using maps (topographic, soils, wetlands) and aerial photos for preidentification of vernal pools (Activities #1, 2, 3, 4, 5, 13, 18, 22, 23, 24, 28)
2. Mapping vernal pools (Activities #23 [Extension], 24, 28)
3. Documenting fluctuations in vernal pool depths and volumes and determining relationships between soils, groundwater, surface water runoff, and pool water regimes (Activities #3, 5, 11)
4. Relating climatic events (temperature, rainfall, day length, etc.) to physical and biological events in vernal pools (in conjunction with biology and/or chemistry) (Activities #2, 3, 5, 11, 13)

History/Political Science/Social Studies

1. History of conservation/wildlife protection/endangered species legislation in the United States (tie into Endangered Species Act reauthorization) (Activities #25, 27)
2. Wetlands protection (United States and Massachusetts)--including local process (legal notices, public hearings, decision making, appeals; could include attendance at a local conservation commission meeting or staging a mock public hearing on a proposed project) (Activities #3 [Extension], 4 [Extension], 27)
3. Public attitudes toward wildlife--especially amphibians and other "lower" animals that typically depend on vernal pools (Activity #26)
4. Private property rights vs. public interests--the "Wise Use" movement, the "taking" issue, and other aspects of conservation and the law in relation to wetlands and watershed protection (Activities #26, 27 [Extension])
5. People and conservation (Activities #25, 26, 27)

Mathematics

1. Angles and geometry for mapping (Activities #19, 22, 23, 24) (see Physical Eduation, Geology and Earth Science listings)
2. Population growth curves for population studies (Activity #2) (see Biology listing)
3. Interest, depreciation, and other aspects of finance (Activities #16, 28) (see Economics/Business examples)
4. Calculating pool areas and volumes (Activity #3 [Extension])

Music

1. Amphibian chorus--singing a chorus based on different frog calls, or composing music based on night sounds at a vernal pool (Activity #13)

Physical Education

1. Orienteering/compass use for locating and mapping pools (Activities #19, 20, 21, 22, 23, 24)
2. Basic woodcraft--getting around in the woods (Activities #19, 20, 21, 22, 23, 24)
3. Relay races and hurdles (Activities #10, 12 [Extension], 22 [Extension])

Appendix 2. Glossary

Abiotic: the nonliving attributes of an environment such as sunlight, temperature, wind, minerals, rainfall.

Algae: simple one-celled or many-celled organisms that photosynthesize; typically free floating or attached to the substrate in fresh or salt water habitats.

Amphibian: a scaleless, moist-skinned (with the exception of toads) vertebrate, with a life cycle that is typically characterized by two stages: young breathe with gills, and the adults breathe with lungs and/or through their skin.

Aquatic: living or growing in or on water.

Assessors Map: a map prepared for a city or town for tax purposes and showing property boundaries and ownership.

Bearing: a directional measurement related to a geographic reference, as the measurements on a compass.

Biodegradability: the property of an object that allows it to naturally decompose and be broken down into simpler substances by bacteria, fungi, and other organisms.

Brumation: the winter dormant or resting stage of a reptile or an amphibian.

Carnivore: an animal or plant that eats other animals.

Certification: the process by which a vernal pool gets officially registered with the Massachusetts Natural Heritage and Endangered Species Program.

Cloaca: in birds, reptiles, and amphibians, a single opening that allows passage of eggs or sperm, urine, and digestive wastes.

Community: the plants and animals in a habitat associated with one another by food webs or other relationships.

Conservation: using natural resources in a way that is in balance with the natural system and ensures their preservation and continuing availability for future generations.

Conservation Commission: a body of appointed people in a community that oversees the administration or carrying out of the Wetlands Protection Act and the protection of natural resources of their city or town.

Consumers: the animals in a food web that utilize the producers (green plants) for food; there may be primary consumers, such as a rabbit that eats plants, or secondary consumers, such as a fox that eats other animals.

Crepuscular: active at dusk.

Crustacean: an animal characterized by a segmented body with a hard outer covering, three major body sections (head, thorax, and abdomen), and jointed appendages on the thorax and abdomen; crayfish, isopods, and fairy shrimp are examples.

Department of Environmental Protection (DEP): a department of state government that oversees environmental programs protecting air, water quality, and wetlands and regulating disposal of solid and hazardous wastes.

Desiccation: drying out; many vernal pool species have eggs that can resist desiccation.

Detritus: nonliving organic matter such as decaying leaves.

Diversity: variety; a habitat rich in diversity contains a variety of different species.

Diurnal: active in the daytime.

Ecosystem: all living and nonliving things in an environment that are linked together by energy and nutrient flow.

Endangered species: a plant or animal species that is threatened with extinction.

Estivation: the summer dormant or resting stage of an animal.

Eutrophication: an increase of nutrients in soil or water. Often this is due to sewage, effluent or fertilizer overflow. In aquatic systems, eutrophication often results in abundant plant growth and algal blooms.

Facultative: able to live in more than one habitat; a facultative vernal pool species can use permanent ponds as well as vernal pools.

Filter feeder: an animal that strains tiny particles and organisms from air or water for food.

Food web: the interdependence of plants and animals, linked together by their feeding interrelationships.

Habitat: the natural environment that a plant or animal normally lives in and that provides some or all of its basic needs.

Herbivore: an animal that feeds on plants.

Hibernation: a special physiological state in which certain mammals reduce their metabolic rate for a period of winter dormancy.

Incubation: maintaining a favorable environment for growth and development of an egg.

Indicator species: plants or animals that are typically found in specific habitats and help identify that habitat.

Insect: an animal with a hard outer skeleton, six legs, one pair of antennae, and three major body sections. Water beetles, diving water bugs, dragonflies, and caddisflies are some of the insects that can be found in vernal pools.

Invertebrate: an animal without a backbone.

Larva: an immature animal that has hatched from an egg; in many insects, a larva becomes a pupa before reaching the adult stage.

Limiting factors: facets of the environment that directly control the health or survival of a species.

Metamorphosis: the change or transformation in an animal's life cycle that marks the transition from one stage to another; (a butterfly metamorphoses from a caterpillar to a butterfly during the pupal stage. A frog metamorphoses gradually from a tadpole to an adult frog).

Metes and Bounds: compass bearings and distances to an object or site (such as a vernal pool) from two or more landmarks.

Migration: the (usually seasonal) movement of a species from one habitat or region to another.

Mollusk: an animal with a soft body and, often, a hard calcium-containing shell; examples include snails, clams, and slugs.

Natural Heritage and Endangered Species Program: a program under the Massachusetts Division of Fisheries and Wildlife that oversees the protection of rare and endangered plant and animal species in the state.

Niche: the combination of specific habitat characteristics, feeding mechanisms, and relationships with other organisms that uniquely characterize a species.

Nocturnal: active by night.

Nymph: the immature stage of an insect that transforms gradually to an adult without going through a pupal stage; some common insect nymphs associated with vernal pools are water boatmen, dragonflies, and mayflies.

Obligate: an obligate vernal pool species is dependent on vernal pools for its survival; it is unable to use permanent ponds, usually because of fish predation.

Omnivore: an animal that feeds on both plant and animal matter.

Orienteering: the process of finding directions in the field or on a map by using the points of a compass.

Organic matter: substances that are or were derived from living organisms, usually referring to compounds that contain carbon.

Pace: in orienteering a pace refers to two steps (right foot, left foot). An average adult's pace is five feet; (to determine your pace, measure out 400 feet and walk that distance counting your paces; divide 400 by the number of paces and you will have your individual pace).

Photosynthesis: the process by which algae and green plants use the sun's energy, carbon dioxide, and water to produce simple sugars. Oxygen is released in the process.

Predator: an organism that feeds on living animals.

Prey: animals that are the food of predators.

Pupa: the stage in the life cycle of an insect between the larva and the adult in which the larva develops adult characteristics such as wings and reproductive structures.

Reptile: a cold-blooded, dry-skinned vertebrate animal that typically has scaly skin and often lays eggs on land. In New England, the five-lined skink, turtles, and snakes make up this group.

Salamander: an amphibian with a tail; vernal pool salamanders include red spotted newts and spotted, blue spotted, Jefferson, and marbled salamanders.

Scavenger: an animal that typically feeds on dead matter.

Shredder: an animal that feeds by breaking down detritus such as decaying leaves into smaller particles.

Species of Special Concern: an animal or plant that is present within its range but whose populations may be in danger.

Spermatophore: a gelatinous capsule that contains sperm and is produced by a male salamander.

Substrate: bottom materials in a habitat, such as mud, leaves, sticks and rocks.

Succession: the changes over time in the order or structure of a community or ecosystem.

Tadpole: the larva of a frog or toad, with a keeled tail and hidden gills. (Salamander larvae, whose gills remain visible, are called larvae, not tadpoles.)

Terrestrial: pertaining to living on land.

Threatened Species: a plant or animal that is likely to become endangered.

Topographic Map: a map on which hills and valleys are represented by contour lines of elevation.

Upland: nonwetland; (when used in reference to wetlands protection, it means the area lacks wetland plants, soils and hydrology).

Vernal: pertaining to spring.

Vertebrate: an animal with a backbone and a bony or cartilaginous internal skeleton.

Wetland: an area where the plants and soils provide evidence of regular or extended flooding or soil saturation.

Wetlands Protection Act: Massachusetts General Laws Chapter 131, Section 30, a law requiring review by local conservation commissions of any activities that may affect wetlands in a city or town.

Zooplankton: small, free-floating animals in an aquatic system.

Appendix 3. References Used in Preparing this Vernal Pool Curriculum Companion

Colburn, Elizabeth A. (Editor). 1993. *Certified: A Citizen's Step-by-Step Guide to Protecting Vernal Pools*. 5th Edition. Massachusetts Audubon Society, Lincoln, MA.

DeGraaf, Richard D. and Deborah M. Rudis.1983. *Amphibians and Reptiles of New England*. University of Massachusetts Press, Amherst, MA.

Kjellstrom, Bjorn. 1976. *Be Expert with Map and Compass*. Scribner, New York, New York.

National Wildlife Federation. 1987. *Ranger Rick's NatureScope* Series (Endangered Species: Wild and Rare, Let's Hear It for Herps!, Wading Into Wetlands). Washington, DC.

Western Association of Fish and Wildlife Agencies and the Western Regional Education Council. 1987. *Aquatic Project WILD*. U.S. Fish and Wildlife Service, Washington, DC.

(See ***Certified*** for a complete Bibliography of Vernal Pool References)

Appendix 4. Addresses

Eastern Mapping Center (NCIC)
U.S. Geological Survey
536 National Center
Reston, VA 22092
(703) 860-6336

Massachusetts Association of Conservation Commissions
10 Juniper Road
Belmont, MA 02178
(617) 489-3930

Massachusetts Audubon Society
208 South Great Road
Lincoln, MA 01773
(617) 259-9500

Natural Heritage and Endangered Species Program
Vernal Pool Certification
Massachusetts Division of Fisheries and Wildlife
100 Cambridge Street
Boston, MA 02202
(617) 727-9194

Reading Memorial High School--Vernal Pool Association
62 Oakland Road
Reading, MA 01867

Appendix 5. Vernal Pool Animal Cards for Activities #6 and 7 (Vernal Pool Bingo and Vernal Pool Concentration Game)

1

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#6 Introduction to Vernal Pool Animals
Teacher's Copy

Wood Frog
-vertebrate
-tan to dark brown in color
-two pronounced ridges leading from eyes down back
-dark patch behind each eye described as robber's mask
-tadpole larva grazes on algae
-lives in woods eating worms, insects and crustaceans
-obligate vernal pool species

Damselfly Nymph
-invertebrate
-an insect (6 legs, three body parts)
-three "tails" serve as gills
-short antennae
-a predator on small crustaceans and insects
-adult has long thin abdomen and holds wings parallel to back when at rest, eats flying insects
-facultative vernal pool species

Spadefoot Toad
-vertebrate
-pupils of eyes are vertically elliptical
-hind feet have single sharp-edged "spade" on their bottom
-skin a little warty, brown to grayish in color
-often has two lines leading from eye down back
-breeds in very short-lived pools
-lives underground
-obligate vernal pool species

Spotted Salamander
-vertebrate
-dark gray to black in color with distinctive circular spots of yellow color on its back and side
-underside grayish white in color
-adults live in woods in underground burrows, crevices, or tunnels and feed on worms, insects and crustaceans
-larvae prey on crustaceans, insects, and other amphibian larvae
-obligate vernal pool species

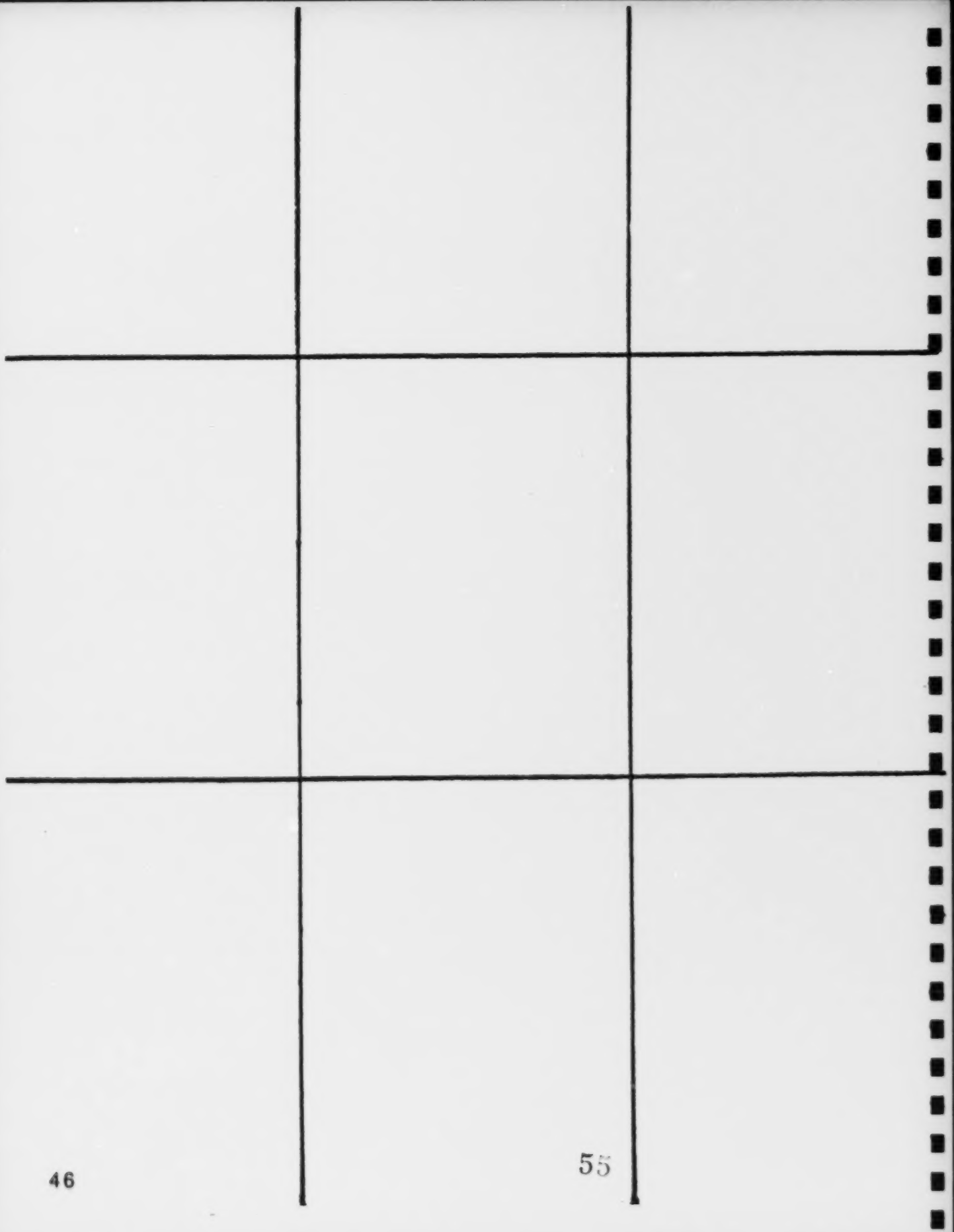
Spring Peeper
-vertebrate
-gray/brown to olive in color
-"suction cups" on toes
-imperfect dark cross on its back
-smallest of Massachusetts' native frogs
-high pitched call, one of the first amphibians to call in the spring
-tadpole larvae graze on algae
-falcultative vernal pool species

Fairy Shrimp
-an invertebrate
-a crustacean
-translucent to orange and white in color
-two antennae
-11 pairs of appendages for swimming, breathing and feeding
-filter feeder
-has desiccation-resistant eggs
-obigate vernal pool species

Blue-Spotted Salamander
-vertebrate
-dark colored with irregular blue or bluish-white spots on its sides and tail that resemble flecks on old enamel-ware pots
-adults live in woods in underground, burrows, crevices, or tunnels and feed on worms, insects, and crustaceans
-larvae predaceous
-obigate vernal pool species

Mayfly Nymph
-an invertebrate
-an insect (6 legs, three body parts)
-usually has three tails
-gills on abdomen
-medium-sized antennae
-adult has clear, somewhat translucent wings
-adults live only a few days and do not feed
-facultative vernal pool species

Marbled Salamander
-vertebrate
-black belly
-black back with irregular white bands that are often "dumbbell shaped"
-breeds in fall rather than spring
-Massachusetts' rarest vernal pool salamander
-lives in woods where it feeds on worms, insects, and crustaceans
-larva predaceous
-obigate vernal pool species



Appendix 6. Life Stages Cards for Activity #7, Extension

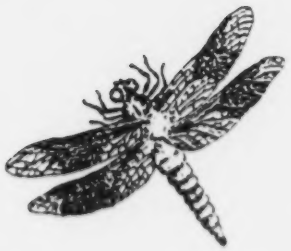
The cards on the following three pages consist of pairs of drawings, illustrating two or three different life stages of a variety of vernal pool species. The cards illustrate the following (the drawing on the left is described first for each pair of drawings).

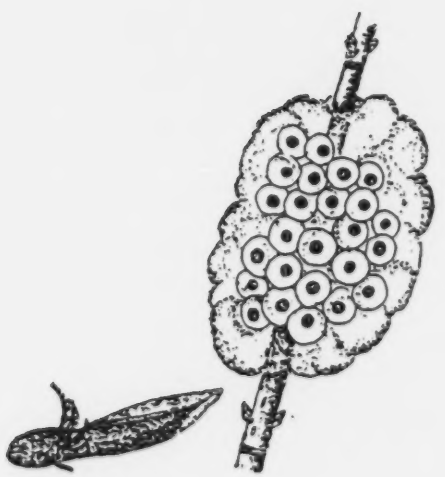
Page 48. Top: dragonfly adult; dragonfly nymph (Insecta, Odonata, Anisoptera, various species in several families). Center: mosquito larva ("wriggler"); adult mosquito (Insecta, Diptera, various species in family Culicidae). Bottom: adult spotted salamander; salamander egg mass and larva (Amphibia, Caudata, Ambystoma maculatum).

Page 49. Top: caddisfly larva in case; caddisfly adult (Insecta, Trichoptera, most commonly species in the families Limnephilidae or Phryganeidae--the limnephilids tend to make "log cabin" cases, while phryganeids tend to have large, thin, tubular cases). Center: fairy shrimp eggs in leaf litter; adult fairy shrimp (Crustacea, Branchiopoda, Eubranchipus vernalis or related species) (NOTE: other invertebrates including worms, water fleas, ostracods, and some insects also have eggs that remain dormant on the dry pool bottom and hatch when the vernal pool refills.) Bottom: string of American Toad eggs; adult American Toad (Amphibia, Anura, Bufo americanus).

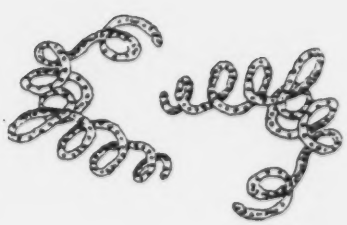
Page 50. Top: mayfly nymph; mayfly adult (Insecta, Ephemeroptera, most commonly species of the family Baetidae). Center: wood frog egg mass and tadpole (larva); wood frog adult (Amphibia, Anura, Rana sylvatica). Bottom: damselfly adult; damselfly nymph (Insecta, Odonata, Zygoptera, various species in several families).

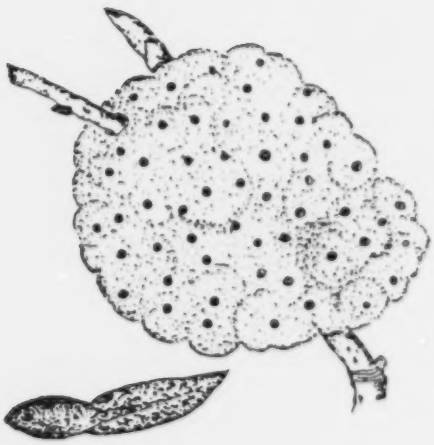
(These cards may also be used to supplement those in Appendix 5, for Activities #6 and 7.)

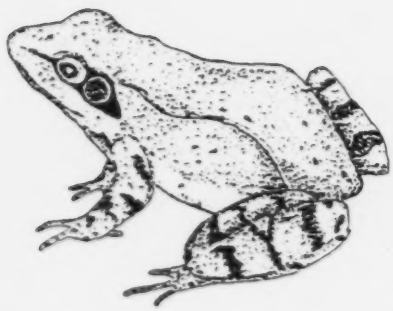




Eggs in Leaf Litter







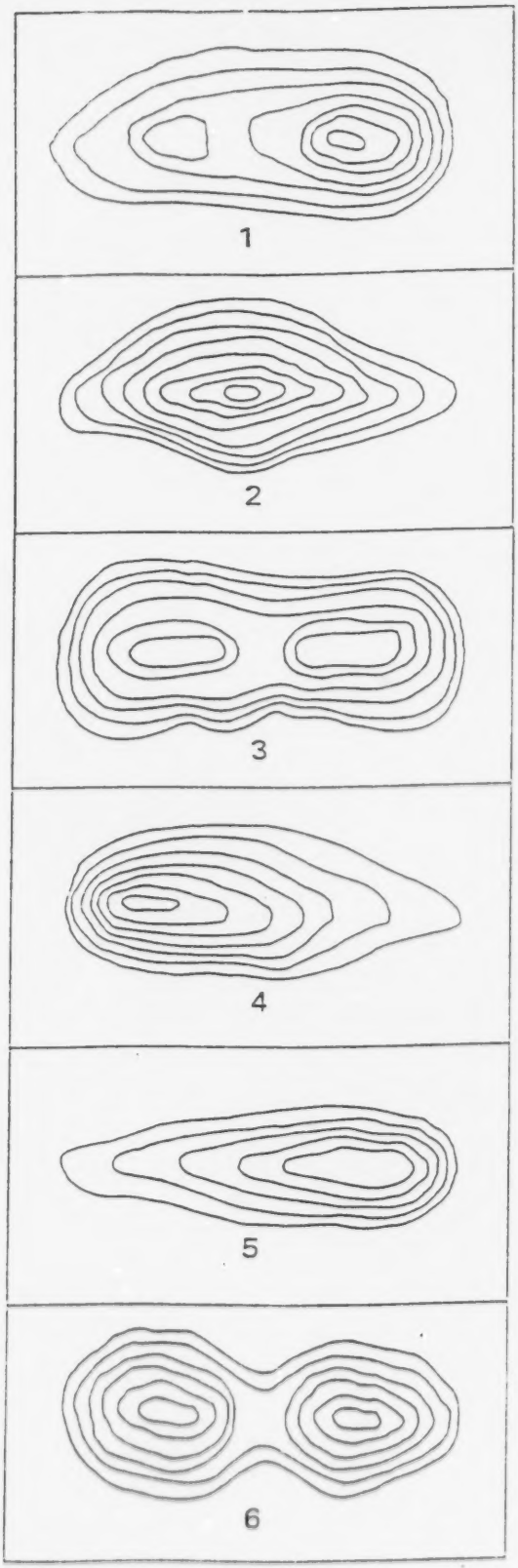
Appendix 7. Contour Matching Sheets for Activity #23

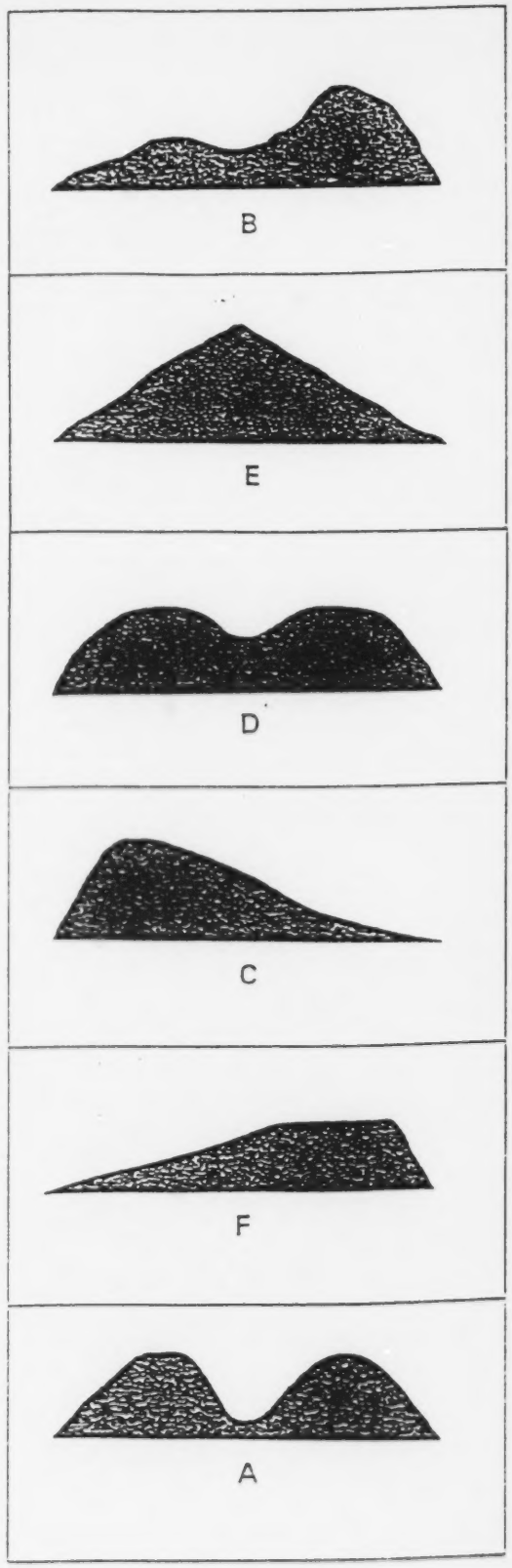
The contours and matching profiles on the following page can be used to illustrate either hills or depressions. (To use as depressions, simply turn both profiles and contours upside-down.)

Activities to be performed with the contours and outlines include:

1. Give the students a set of contours, and have them draw the corresponding profiles.
2. Give the students a set of outlines, and have them draw the corresponding contours.
3. Give the students both contours and outlines and have them match them by either drawing connecting lines or listing the appropriate identification number and letter for each pair.

(Source: *Be Expert With Map and Compass*, by Bjorn Kjellstrom, 1976. Scribner, New York, page 33.)


1
2
3
4
5
6


B
E
D
C
F
A